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ABSTRACT

In an attempt to replicate an earlier study by H. G. Schmidt, H. P. A. Boshuizen, and P. P. M. Hobus (1988), 96 students and physicians at the University of Limburg (Netherlands) studied 4 clinical cases, produced a diagnosis, and recalled each case. Subjects were 24 second-year, 24 fourth-year, and 24 sixth-year medical students and 24 internists with at least 4 years of experience in internal medicine. In addition, processing time was manipulated. Diagnostic accuracy increased with level of expertise. Unexpectedly, the study failed to disclose an intermediate effect in the recall data. A positive, linear relationship between expertise level and case recall was found. Constraining processing time did not affect diagnostic accuracy, but equally affected the recall performance of the various expertise levels. The results are interpreted in terms of the inability of even expert physicians to process laboratory data in an automatic fashion. Two figures illustrate the report. (Contains 16 references.) (SLD)

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A failure to reproduce the intermediate effect in clinical case recall

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Abstract

The present study attempted to replicate an earlier study by Schmidt, Boshuizen, & Hobus (1988). Subjects studied four clinical cases, produced a diagnosis and recalled each case. In addition, processing time was manipulated. Diagnostic accuracy increased with level of expertise. Unexpectedly, the study failed to disclose an intermediate effect in the recall data: a positive, linear relation between expertise level and case recall was found. Constraining processing time did not affect diagnostic accuracy, but equally affected the recall performance of the various expertise levels. The results are interpreted in terms of the inability of even expert physicians to process laboratory data in an automatic fashion.

Theories of text-processing generally assume that prior knowledge facilitates new information encoding and retrieval (e.g., Bransford & Johnson, 1972). New information from text and prior knowledge interact in the resulting mental representation. Studies using free recall of meaningful texts assume that the recall reflects content and structure of the mental representation of the text. Since experts have access to more elaborate and more coherent knowledge structures they are conjectured to recall more information from the text than novices. Research on expertise in domains such as chess (De Groot, 1965), baseball (Spilich, Vesonder, Chiesi, & Voss, 1979), bridge (Charness, 1979), and computer-programming (McKeithen, Reitman, Rueter, & Hirtle, 1981) support this hypothesis.

Studies on expertise in the domain of medicine, however, do not produce such a clear-cut linear relationship. Only few recall studies have demonstrated a positive relationship with level of expertise (Hobus, Schmidt, Boshuizen, & Patel, 1987; Norman, Brooks, & Allen, 1989). Quite a number of researchers have failed to find significant effects of expertise level on the amount of information recalled, although effects were found on related measures such as recall per unit study time or recall time (e.g., Claessen & Boshuizen, 1985; Norman, Jacoby, Feightner, & Campbell, 1979). Finally, a number of other studies demonstrated an inverted U-shaped relation between level of expertise and amount of clinical case recall, the so-called "intermediate effect" (e.g., Gilhooly, McGeorge, Hunter, Rawles, Kirby, Green, Wynn, & Simpson, 1992; Patel & Groen, 1991; Patel & Medley-Mark, 1986; Schmidt & Boshuizen, in press; Schmidt, Boshuizen, & Hobus, 1988). A meta-analysis of outcomes of 12 recall studies conducted between 1979 and 1989 suggests that the inverted U-shaped relation better describes the combined results than a monotonically increasing function (Boshuizen, 1989). Schmidt and Boshuizen (in press) hypothesized that this decline in recall performance beyond the intermediate level might result from different ways of case processing due to knowledge restructuring. In diagnosing a case students have to reason through their rich, elaborated causal networks explaining the causes and consequences of disease in terms of general underlying biological or pathophysiological processes. Through extensive and repeated application of acquired knowledge, and particularly through exposure to patient problems, clusters of lower order concepts in these causal networks become encapsulated into some higher level concepts or diagnostic labels. Schmidt and Boshuizen found empirical evidence for this assumption by experimentally manipulating case processing in medical students and experts.

The 1988 study by Schmidt and colleagues plays a crucial role in the theory by Schmidt, Norman and Boshuizen (1991) about the development of medical expertise. In this study it was found that medical experts remembered less from a case than advanced students when given ample time to process a case; yet their diagnostic performance and their recall were not affected by a sizable reduction in processing time, whereas the students' performance in fact was. Because of this central role of this phenomenon in their theory, we decided to replicate this study. However, instead of one, four cases were presented, taken from four different specialty areas in internal medicine.

Method

Subjects. Subjects were 96 students and physicians of the University of Limburg: 24 second-year, 24 fourth-year and 24 sixth-year medical students and 24 internists with at least 4 years of experience in internal medicine. Each group of 24 was randomly subdivided into three groups of eight who were assigned to three time constraint conditions. Subjects received a small compensation for their participation.

Material. The materials consisted of four booklets, each containing a description of a clinical case and two blank response sheets. Each clinical case description reported some contextual information and complaint, the case history, the physical examination, the relevant laboratory data and some additional findings. The case descriptions were about half a page in length and consisted of 33, 42, 43, and 35 propositions respectively. The four clinical cases, pheohromocytoma, stomach carcinoma, heart failure and liver cirrhosis, were based on actual patients and were presented as a narrative.

Procedure. Subjects were told that four cases would be presented and that it would be their task to produce a diagnosis and to write down what they remembered from the case. Then an example case was presented in order to make them familiar with the case format in this experiment and to experience the reading time allowed. Depending on the experimental condition subjects were given the opportunity to read each case for 3 minutes (3'00"), 1 minute and 15 seconds (1'15"), or 30 seconds (30"). Subjects were free to use as much time as they needed for the assignments. The order of case presentation was balanced.

Analysis. Diagnoses were scored on a scale ranging from 0 (incorrect diagnosis) to 6 (completely correct diagnosis) for each case. Recall protocols were segmented into small meaningful information units referred to as propositions.

The number of correct propositions was tallied. Reliabilities of these procedures exceeded .98. Manova with repeated measures was used to analyze the data.

Results and discussion

Figure 1 shows diagnostic accuracy as a function of level of expertise and processing time. A significant main effect of level of expertise on diagnostic accuracy was found, $F(3,84) = 68{,}68$, $p = .0001$. An increase in diagnostic accuracy is considered one of the most stable effects of medical expertise. Therefore, we can conclude that the subjects' tasks in this experimental setting were ecologically valid. The effect of processing time was not significant $F(3,84) = .29$, $p = .75$. The same effect was found by Schmidt et al. (1988). This suggests that processing a clinical case in order to formulate a diagnosis directs the attention of the subjects in such a way that they are equally capable or incapable of fulfilling this task in 3'.00", 1'.15" or 30".

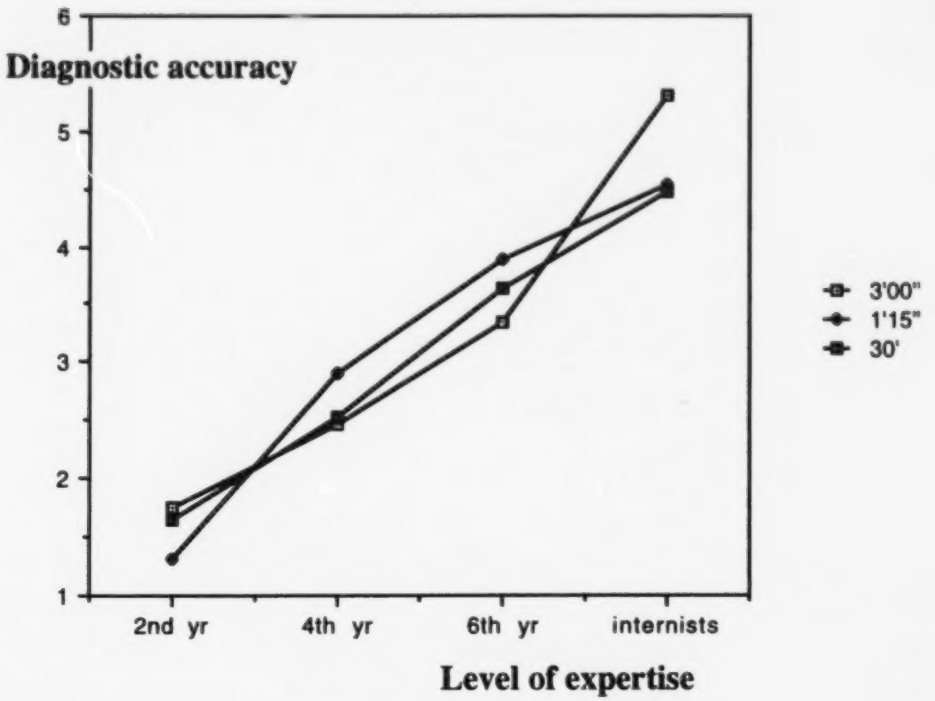

Figure 1. Average accuracy of diagnoses as a function of expertise level and processing time.

The graph depicting the relation between average number of propositions recalled, level of expertise and processing time (see Figure 2) shows a positive linear recall function with expertise, $F(3,84) = 10.27$, $p = .0001$. In addition the main effect of processing time is significant as well, $F(3,84) = 59.89$, $p = .0001$, but no interaction effect of processing time and level of expertise occurred.

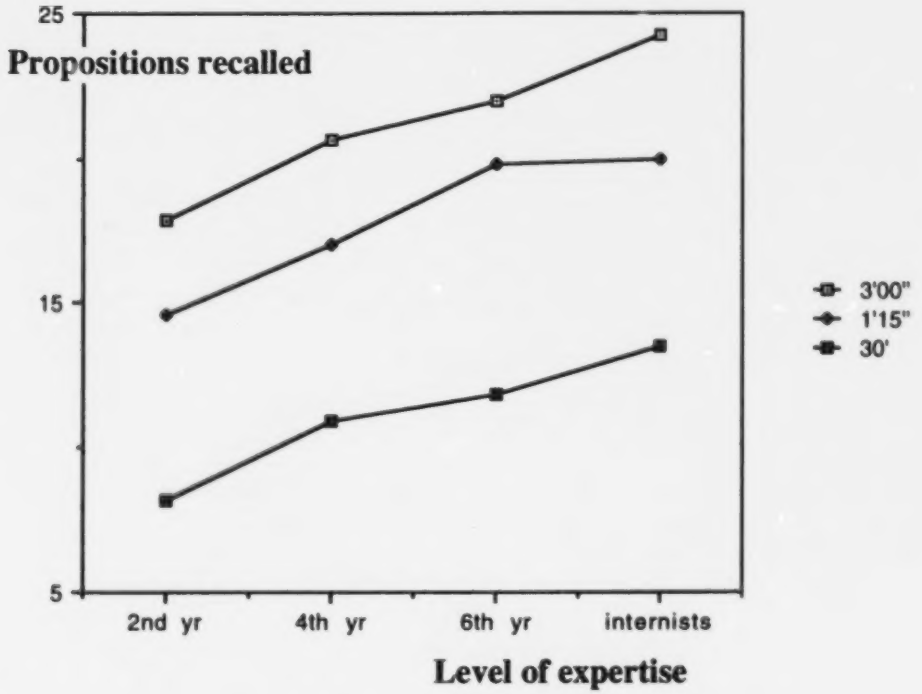

Figure 2. Average number of propositions recalled as a function of expertise level and processing time.

These results clearly contradict the results of the Schmidt et al. (1988) study. There it was found that medical experts remembered less from a case than medical students in the long processing time condition. The experts' recall, however, was not affected by constraining processing time, whereas the students' recall was. The question, then, is how the discrepancies between the present study and the Schmidt et al. study can be explained.

First, the present experiment used four cases instead of one. There is some evidence that experts consider the clinical case representation task initially as a problem-solving task (Schmidt & Boshuizen, in press), making recall performance incidental to that task. However, presentation of four cases may

lead them to adapt to the requirements of the experiment and improve their performance on later cases. Analysis of the effect of presentation order on the number of case propositions recalled accurately showed indeed a significant effect, $F(3, 357) = 2.998$, $p = .03$. This position effect, however, can not completely account for the failure to replicate the intermediate effect, since recall performance on the first case also showed a significant, positive, linear relationship with level of expertise.

Further procedures and conditions of both experiments were the same except that different cases were used. Therefore a second explanation for the discrepancy must be sought in the main difference between the cases, which is the presence of numerical lab data in the cases of the present study. The bacterial endocarditis case used by Schmidt et al. contained virtually no lab data, whereas all four cases in the present study contained approximately 25% lab data in a numerical form. Studies of numerical lab data recall by Norman et al (1989) indicate that, in those cases, even expert physicians cannot built up a mental representation of the clinical problem at hand automatically and immediately, but have to process the lab data in an analytical fashion, combining data from various tests. This analytical approach to the data may lead to better recall (which was what Norman and his collaborators found). If the processing of lab data proceeds in a different mode than the processing of other signs and symptoms presented in a case, the failure to find an intermediate effect in the present study may be explained. This possibility is presently under study in our lab.

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